NATURAL RESOURCES CONSERVATION SERVICE
MONTANA CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT (ACRE)

CODE 590

DEFINITION

Managing the amount, source, placement, form and timing of the application of plant nutrients and soil amendments.

PURPOSE

- To budget and supply nutrients for plant production.
- To properly utilize manure or organic by-products as a plant nutrient source.
- To minimize agricultural nonpoint source pollution of surface and ground water resources.
- To protect air quality by reducing nitrogen emissions (ammonia and NO_x compounds) and the formation of atmospheric particulates.
- To maintain or improve the physical, chemical and biological condition of soil.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where plant nutrients and soil amendments are applied.

CRITERIA

General Criteria Applicable to All Purposes

A nutrient budget for nitrogen, phosphorus, and potassium shall be developed that considers all potential sources of nutrients including, but not limited to animal manure and organic by-products, waste water, commercial fertilizer, crop residues, legume credits, and irrigation water.

Realistic yield goals shall be established based on soil productivity information, historical yield data, climatic conditions, level of management and/or local research on similar soil, cropping systems, and soil and manure/organic by-products tests.

For new crops or varieties, industry yield recommendations may be used until documented yield information is available.

Plans for nutrient management shall specify the source, amount, timing and method of application of nutrients on each field to achieve realistic production goals, while minimizing movement of nutrients and other potential contaminants to surface and/or ground waters.

Areas contained within established minimum application setbacks (e.g., sinkholes, wells, gullies, ditches, surface inlets or rapidly permeable soil areas) shall not receive direct application of nutrients.

The amount of nutrients lost to erosion, runoff, irrigation and drainage, shall be addressed, as needed. **Water erosion prediction estimates must meet soil loss tolerance levels for the design soil during years of nutrient application. Where erosion levels do not meet soil loss tolerance levels, mitigation practices must be installed to ensure protection of surface and ground water resources.**

Soil and Tissue Sampling and Laboratory Analyses (Testing). Nutrient planning shall be based on current soil and tissue (where used as a supplement) test results developed in accordance with Land Grant University guidance, or industry practice if recognized by the Land Grant University. Current soil tests are those that are no older than five years.

Soil and tissue samples shall be collected and prepared according to the Land Grant University guidance or standard industry practice **(refer to Montguide MT8602 for soil testing techniques)**. Soil and tissue test analyses shall be performed by laboratories that are accepted in one or more of the following:

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard contact the Natural Resources Conservation Service.

NOTE: This type of font **(AaBbCcDdEe 123..)** indicates NRCS National Standards.
This type of font (AaBbCcDdEe 123..) indicates Montana Supplement.

- Laboratories successfully meeting the requirements and performance standards of the North American Proficiency Testing Program (NAPT) under the auspices of the Soil Science Society of America, or

- State recognized program that considers laboratory performance and proficiency to assure accuracy of soil test results.

Soil and tissue testing shall include analyses for any nutrients for which specific information is needed to develop the nutrient plan. Request analyses pertinent to monitoring or amending the annual nutrient budget, e.g., pH, electrical conductivity (EC), soil organic matter, nitrogen, phosphorus and potassium.

Nutrient Application Rates. Soil amendments shall be applied, as needed, to adjust soil pH to an adequate level for crop nutrient availability and utilization.

Recommended nutrient application rates shall be based on Land Grant University recommendations (and/or industry practice when recognized by the university) that consider current soil test results, realistic yield goals and management capabilities. If the Land Grant University does not provide specific recommendations, application shall be based on realistic yield goals and associated plant nutrient uptake rates.

The planned rates of nutrient application, as documented in the nutrient budget, shall be determined based on the following guidance:

- Nitrogen Application - Planned nitrogen application rates shall match the recommended rates as closely as possible, except when manure or organic by-products are a source of nutrients. When manure or organic by-products are a source of nutrients, see "Additional Criteria" below.

- Phosphorus Application - Planned phosphorus application rates shall match the recommended rates as closely as possible, except when manure or organic by-products are sources of nutrients. When manure or organic by-products are a source of nutrients, see "Additional Criteria" below.

- Potassium Application - Potassium shall not be applied in situations in which excess (greater than soil test potassium recommendation) causes unacceptable nutrient imbalances in crops or forages. When forage quality is an issue associated with excess potassium application, state standards shall be used to set forage quality guidelines.

- Other Plant Nutrients - The planned rates of application of other nutrients shall be consistent with Land Grant University guidance or industry practice if recognized by the Land Grant University in the state.

- Starter Fertilizers - When starter fertilizers are used, they shall be included in the overall nutrient budget, and applied in accordance with **Montana State University (MSU)** Land Grant University recommendations, or industry practice if recognized by **MSU**.

Nutrient Application Timing. Timing and method of nutrient application (particularly nitrogen) shall correspond as closely as possible with plant nutrient uptake characteristics, while considering cropping system limitations, weather and climatic conditions, risk assessment tools (e.g., leaching index, P index) and field accessibility.

Nutrient Application Methods. Application methods to reduce the risk of nutrient transport to surface and ground water, or into the atmosphere shall be employed.

To minimize nutrient losses:

- Apply nutrient materials uniformly to application area(s).

- Nutrients shall not be applied to frozen, snow-covered or saturated soil if the potential risk for runoff exists. **Potential risk is considered negligible when RUSLE2 soil loss prediction is 2 T/A/Y or less.**

- Nutrients shall be applied considering the plant growth habits, irrigation practices, and other conditions so as to maximize availability to the plant and minimize the risk of runoff, leaching, and volatilization losses.

- Nutrient applications associated with irrigation systems shall be applied in a manner that prevents or minimizes resource impairment.

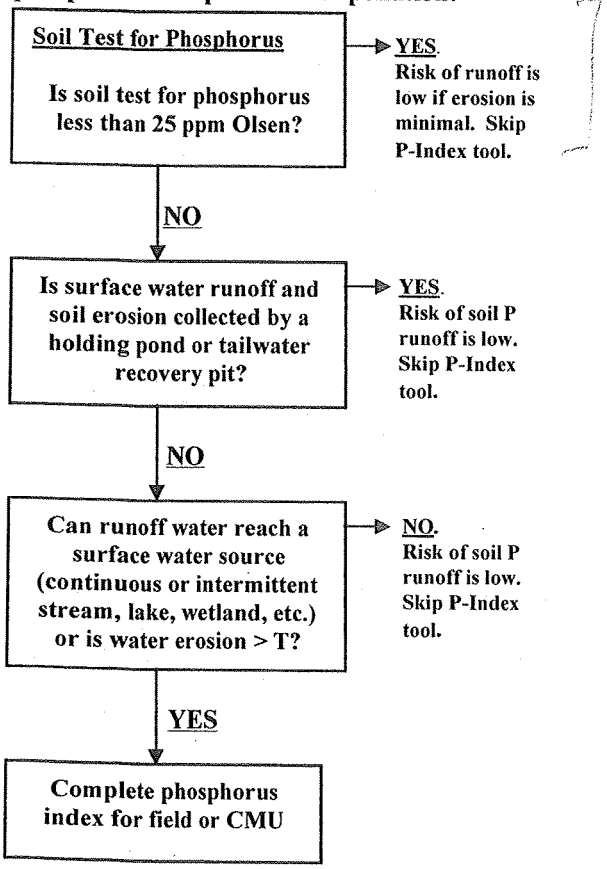
Conservation Management Unit (CMU) Risk Assessment. In areas with identified or designated nutrient related water quality impairment, a CMU specific risk assessment of the potential for nutrient transport from the area shall be completed.

States that utilize a threshold prescreening procedure to trigger CMU risk assessment shall follow approved procedures as recommended by the respective state or Land Grant University.

Use an appropriate nutrient risk assessment tool for the nutrient in question (e.g., leaching index, phosphorus index) or other state recognized assessment tool. **The phosphorus index and nitrogen index are the risk assessment tools utilized in Montana.**

When a risk assessment tool is used, nutrient plans shall include a record of the assessment rating for each CMU. Plans will also include information about selected conservation practices and management activities that will reduce the potential for phosphorus movement from the site.

The following preliminary screening tool can be used to determine whether there is potential for phosphorus non-point source pollution:



Additional Criteria Applicable to Manure and Organic By-Products or Biosolids Applied as a Plant Nutrient Source

When animal manures or organic by-products are applied, a risk assessment of the potential for nutrient transport from the CMU shall be completed to adjust the amount, placement, form and timing of application of nutrient sources, as recommended by the respective state or Land Grant University. **The phosphorus index and the nitrogen index are required for planning of all animal manure applications in Montana.**

Nutrient values of manure and organic by-products (excluding sewage sludge or bio-solids) shall be determined prior to land application. Samples will be taken and analyzed with each hauling/emptying cycle for a storage/treatment facility. Manure sampling frequency may vary based on the operation's manure handling strategy and spreading schedule. If there is no prior sampling history, the manure shall be analyzed at least annually for a minimum of three consecutive years. A cumulative record shall be developed and maintained until a consistent (maintaining a certain nutrient concentration with minimal variation) level of nutrient values is realized. The average of results contained in the operation's cumulative manure analyses history shall be used as a basis for nutrient allocation to fields. Samples shall be collected and prepared according to Land Grant University guidance or industry practice. **Initial applications, where historical analysis is not available for Montana, can be based upon Manure Management Planner (MMP) calculations until a three year sampling history is documented.**

In planning for new operations, **MMP may be used to** estimate nutrient output from the proposed operation. Bio-solids (sewage sludge) shall be applied in accordance with USEPA regulations. (40 CFR Parts 403 (Pretreatment) and 503 (Bio-solids) and other state and/or local regulations regarding the use of bio-solids as a nutrient source.

Manure and Organic By-Product Nutrient Application Rates. Manure and organic by-product nutrient application rates shall be based on nutrient analyses procedures recommended by the respective state or Land Grant University. As indicated above, **MMP** may be used in planning for new operations. At a minimum, manure analyses shall identify nutrient and specific ion concentrations, percent moisture, and percent organic matter. Salt concentration shall be monitored so that manure applications do not cause plant damage or negatively impact soil quality.

The application rate (in/hr) of liquid materials applied shall not exceed the soil intake/infiltration rate and shall be adjusted to minimize ponding and to avoid runoff. The total application shall not

exceed the field capacity of the soil and shall be adjusted, as needed, to minimize loss to subsurface tile drains.

The planned rates of nitrogen and phosphorus application recorded in the plan shall be determined based on the following guidance:

Nitrogen Application Rates

- When manure or organic by-products are used, the nitrogen availability of the planned application rates shall match plant uptake characteristics as closely as possible, taking into consideration the timing of nutrient application(s) in order to minimize leaching and atmospheric losses.

- Management activities and technologies shall be used that effectively utilize mineralized nitrogen and that minimize nitrogen losses through denitrification and ammonia volatilization.

- Manure or organic by-products may be applied on legumes at rates equal to the estimated removal of nitrogen in harvested plant biomass.

- When the nutrient management plan component is being implemented on a phosphorus basis, manure or organic by-products shall be applied at rates consistent with a phosphorus limited application rate. In such situations, an additional nitrogen application, from non-organic sources, may be required to supply, but not exceed, the recommended amounts of nitrogen in any given year.

Phosphorus Application Rates

- When manure or organic by-products are used, the planned rates of phosphorus application shall be consistent with any one of the following options:

  - ◊ Phosphorus Index (PI) Rating. Nitrogen-based manure application on Low or Medium Risk Sites; phosphorus-based or no manure application on High and Very High Risk Sites **(see Agronomy Technical Note 80.1, Phosphorus Index Assessment for Montana, and Table 8-Phosphorus Application Based on PI)**.

  - ◊ Soil Test. Nitrogen-based manure application on sites for which the soil test recommendation calls for phosphorus application; phosphorus-based or no manure application on sites for which the soil test recommendation calls for no phosphorus application **(see Table 9. Nutrient Management Specification MT590-7)**.

- The application of phosphorus applied as manure may be made at a rate equal to the recommended phosphorus application or estimated phosphorus removal in harvested plant biomass for the crop rotation or multiple years in the crop sequence. **Crop removal rates shall be estimated using the NRCS Crop Nutrient Tool found at http://npk.nrcs.usda.gov**. When such applications are made, the application rate shall:

  - ◊ Not exceed the recommended nitrogen application rate during the year of application, or

  - ◊ Not exceed the estimated nitrogen removal in harvested plant biomass during the year of application when there is no recommended nitrogen application.

  - ◊ Not be made on sites considered vulnerable to off-site phosphorus transport unless appropriate conservation practices, best management practices or management activities are used to reduce the vulnerability.

Heavy Metal Monitoring. When sewage sludge (bio-solids) is applied, the accumulation of potential pollutants (including arsenic, cadmium, copper, lead, mercury, selenium, and zinc) in the soil shall be monitored in accordance with the US Code, Reference 40 CFR, Parts 403 and 503, and/or any applicable state, **tribal,** and local laws or regulations.

Additional Criteria to Protect Air Quality by Reducing Nitrogen and/or Particulate Emissions to the Atmosphere

In areas with an identified or designated nutrient management related air quality concern, any component(s) of nutrient management (i.e., amount, source, placement, form, timing of

application) identified by risk assessment tools as a potential source of atmospheric pollutants shall be adjusted, as necessary, to minimize the loss(es).

When tillage can be performed, surface applications of manure and fertilizer nitrogen formulations that are subject to volatilization on the soil surface (e.g., urea) shall be incorporated into the soil within 24 hours after application.

When manure or organic by-products are applied to grassland, hayland, pasture or minimum-till areas the rate, form and timing of application(s) shall be managed to minimize volatilization losses.

When liquid forms of manure are applied with irrigation equipment, operators will select weather conditions during application that will minimize volatilization losses.

Operators will handle and apply poultry litter or other dry types of animal manures when the potential for wind-driven loss is low and there is less potential for transport of particulates into the atmosphere.

Weather and climatic conditions during manure or organic by-product application(s) shall be recorded and maintained in accordance with the operation and maintenance section of this standard.

Additional Criteria to Improve the Physical, Chemical and Biological Condition of the Soil

Nutrients shall be applied and managed in a manner that maintains or improves the physical, chemical and biological condition of the soil.

Minimize the use of nutrient sources with high salt content unless provisions are made to leach salts below the crop root zone **when required for Montana.**

To the extent practicable nutrients shall not be applied when the potential for soil compaction and rutting is high.

CONSIDERATIONS

The use of management activities and technologies listed in this section may improve both the production and environmental performance of nutrient management systems.

The addition of these management activities, when applicable, increases the management intensity of the system and is recommended in a nutrient management system.

Action should be taken to protect National Register listed and other eligible cultural resources.

The nutrient budget should be reviewed annually to determine if any changes are needed for the next planned crop.

For sites on which there are special environmental concerns, other sampling techniques may be appropriate. These include soil profile sampling for nitrogen, Pre-Sidedress Nitrogen Test (PSNT), Pre-Plant Soil Nitrate Test (PPSN) or soil surface sampling for phosphorus accumulation or pH changes.

Additional practices to enhance the producer's ability to manage manure effectively include modification of the animal's diet to reduce the manure nutrient content, or utilizing manure amendments that stabilize or tie-up nutrients.

For best results for Montana, soil test information should be no older than one year when developing new plans, particularly if animal manures are to be used as a nutrient source.

Excessive levels of some nutrients can cause induced deficiencies of other nutrients.

If increases in soil phosphorus levels are expected, consider a more frequent (annual) soil testing interval.

To manage the conversion of nitrogen in manure or fertilizer, use products or materials (e.g., nitrification inhibitors, urease inhibitors and slow or controlled release fertilizers) that more closely match nutrient release and availability for plant uptake. These materials may improve the nitrogen use efficiency (NUE) of the nutrient management system by reducing losses of nitrogen into water and/or air.

Considerations to Minimize Agricultural Nonpoint Source Pollution of Surface and Ground Water.

Erosion control and runoff reduction practices can improve soil nutrient and water storage, infiltration, aeration, tilth, diversity of soil organisms and protect or improve water and air quality.

Cover crops can effectively utilize and/or recycle residual nitrogen.

Apply nutrient materials uniformly to the application area. Application methods and timing that reduce the risk of nutrients being transported to ground and surface waters, or into the atmosphere include:

- Split applications of nitrogen to provide nutrients at the times of maximum crop utilization,
- Use stalk-test to minimize risk of over applying nitrogen in excess of crop needs.
- Avoid winter nutrient application for spring seeded crops,
- Band applications of phosphorus near the seed row,
- Incorporate surface applied manures or organic by-products as soon as possible after application to minimize nutrient losses,
- Delay field application of animal manures or organic by-products if precipitation capable of producing runoff and erosion is forecast within 24 hours of the time of the planned application.
- **Apply nutrients, for Montana, as close as possible to time of use to reduce potential for surface and ground water contamination.**

Considerations to Protect Air Quality by Reducing Nitrogen and/or Particulate Emissions to the Atmosphere.

Odors associated with the land application of manures and organic by-products can be offensive to the occupants of nearby homes. Avoid applying these materials upwind of occupied structures when residents are likely to be home (evenings, weekends and holidays).

When applying manure with irrigation equipment, modifying the equipment can reduce the potential for volatilization of nitrogen from the time the manure leaves the application equipment until it reaches the surface of the soil (e.g., reduced pressure, drop down tubes for center pivots). N volatilization from manure in a surface irrigation system will be reduced when applied under a crop canopy.

When planning nutrient applications and tillage operations, encourage soil carbon buildup while discouraging greenhouse gas emissions (e.g., nitrous oxide N_2O, carbon dioxide CO_2).

Nutrient applications associated with irrigation systems should be applied in accordance with the requirements of Irrigation Water Management (Code 449).

CAFO operations seeking permits under USEPA regulations (40 CFR Parts 122 and 412) should consult with their respective state permitting authority for additional criteria.

PLANS AND SPECIFICATIONS

Plans and specifications for nutrient management shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose(s), using nutrients to achieve production goals and to prevent or minimize resource impairment.

Nutrient management plans shall include a statement that the plan was developed based on requirements of the current standard and any applicable Federal, state, or local regulations, policies, or programs, which may include the implementation of other practices and/or management activities. Changes in any of these requirements may necessitate a revision of the plan.

The following components shall be included in the nutrient management plan:

- aerial site photograph(s) or site map(s), and a soil survey map of the site,
- location of designated sensitive areas or resources and the associated, nutrient management restriction,
- current and/or planned plant production sequence or crop rotation,
- results of soil, water, manure and/or organic by-product sample analyses,
- results of plant tissue analyses, when used for nutrient management,
- realistic yield goals for the crops,
- complete nutrient budget **(see Montana Job Sheet, MT-ECS-590B)** for nitrogen, phosphorus, and potassium for the crop rotation or sequence,
- listing and quantification of all nutrient sources,

- CMU specific recommended nutrient application rates, timing, form, and method of application and incorporation,
- guidance for implementation, operation, maintenance, and recordkeeping, and

If increases in soil phosphorus levels are expected, the nutrient management plan shall document:

- the soil phosphorus levels at which it may be desirable to convert to phosphorus based planning,
- results of appropriate risk assessment tools to document the relationship between soil phosphorus levels and potential for phosphorus transport from the field,
- the potential for soil phosphorus drawdown from the production and harvesting of crops, and
- management activities or techniques used to reduce the potential for phosphorus loss.

OPERATION AND MAINTENANCE

The owner/client is responsible for safe operation and maintenance of this practice including all equipment. Operation and maintenance addresses the following:

- periodic plan review to determine if adjustments or modifications to the plan are needed. As a minimum, plans will be reviewed and revised with each soil test cycle.
- significant changes in animal numbers and/or feed management will necessitate additional manure sampling and analyses to establish a revised average nutrient content.
- protection of fertilizer and organic by-product storage facilities from weather and accidental leakage or spillage.
- calibration of application equipment to ensure uniform distribution of material at planned rates.
- documentation of the actual rate at which nutrients were applied. When the actual rates used differ from the recommended and planned rates, records will indicate the reasons for the differences.
- Maintaining records to document plan implementation. As applicable, records include:
  - Soil, plant tissue, water, manure, and organic by-product analyses resulting in recommendations for nutrient application,
  - quantities, analyses and sources of nutrients applied,
  - dates and method(s) of nutrient applications,
  - weather conditions and soil moisture at the time of application; lapsed time to manure incorporation, rainfall or irrigation event.
  - crops planted, planting and harvest dates, yields, and crop residues removed,
  - dates of plan review, name of reviewer, and recommended changes resulting from the review.

Records should be maintained for five years; or for a period longer than five years if required by other Federal, state or local ordinances, or program or contract requirements.

Workers should be protected from and avoid unnecessary contact with plant nutrient sources. Extra caution must be taken when handling ammoniacal nutrient sources, or when dealing with organic wastes stored in unventilated enclosures.

Material generated from cleaning nutrient application equipment should be utilized in an environmentally safe manner. Excess material should be collected and stored or field applied in an appropriate manner.

Nutrient containers should be recycled in compliance with state, **tribal,** and local guidelines or regulations.

REFERENCES

Follett, R.F. 2001. Nitrogen Transformation and Transport Processes. pp. 17-44. In R.F. Follett and J. Hatfield. (eds.). 2001. Nitrogen in the Environment; Sources, Problems, and Solutions. Elsevier Science Publishers. The Netherlands. 520 pp.

Sims, J.T. (ed.) 2005. Phosphorus: Agriculture and the Environment. Agron. Monogr. 46. ASA, CSSA, and SSSA, Madison, WI.

Stevenson, F.J. (ed.) 1982. Nitrogen in Agricultural Soils. Agron. Series 22. ASA, CSSA, and SSSA, Madison, WI.

Fertilizer Guidelines for Montana Crops, Montana State University, Extension Service Bulletin EB 161. January 2003.

USDA–Natural Resources Conservation Service, National Engineering Handbook, Agricultural Waste Management Field Handbook, Part 651, Chapters 4, 6, 11, and 16.

Montana State University Extension Service, Department of Plant, Soil, and Environmental Science, Soil Testing Procedures, Interpretation and Fertilizer Sources, Montguide MT 8704, Bozeman, Montana.

Montana State University Extension Service, Department of Plant, Soil, and Environmental Science, Soil Sampling, Montguide MT 8602, Bozeman, Montana.

NATURAL RESOURCES CONSERVATION SERVICE
MONTANA CONSERVATION PRACTICE SPECIFICATION

NUTRIENT MANAGEMENT (ACRE)

CODE 590

PRODUCER

TRACT. / FIELD NO. / CTU

DEFINITION: Nutrient management is managing the amount, source, placement, form, and timing of plant nutrients and soil amendments.

PURPOSE: Nutrient management effectively and efficiently uses scarce nutrient resources to adequately supply soils and plants appropriate nutrients to produce food, forage, fiber, and cover while minimizing environmental degradation. Nutrient management is applicable to all lands where plant nutrients and soil amendments are applied.

CONSERVATION MANAGEMENT SYSTEMS. Nutrient management may be a component of a conservation management system. It is used in conjunction with crop rotation, residue management, pest management, conservation buffer practices, and/or other practices needed on a site-specific basis to address natural resource concerns and producer objectives. The major role of nutrient management is to minimize nutrient losses from fields, thus helping protect surface and ground water supplies.

NUTRIENT MANAGEMENT PLANNING. The nutrient management plan is a dynamic tool and must be monitored and adjusted on an annual basis. As a minimum, a nutrient budget for nitrogen, phosphorus, and potassium will be designed that considers all sources of nutrients including animal manures, organic by-products, waste water, irrigation water, commercial fertilizer, crop residues, legumes, and atmospheric deposition.

Nutrient management components of the conservation plan will include the following information:

- Field maps and soil maps
- Planned crop rotation or sequence
- Results of soil, water, plant, and organic materials sample analysis
- Realistic expected yields
- Sources of all nutrients to be applied
- Nutrient budget, including credits of nutrients available
- Nutrient rates, form, timing, and application method to meet crop demands and soil quality concerns
- Location of designated sensitive areas
- Guidelines for operation and maintenance.

Nutrient management is most effective when used with other agronomic practices, such as cover or green manure crops, residue management, conservation buffers, water management, pest management, and crop rotation.

Expected Yield.

Method 1. **YIELD GOALS OF CEREALS AND SAFFLOWER** can be calculated using the following procedure:

Refer to Agronomy Technical Note 110.4, Determining Plant Available Moisture for Flex-Crop Systems, to determine (a) plant available soil moisture, and (b) growing season precipitation in inches based on 70 percent probability. Determine consumptive use from FOTG, Section I, Maps, Irrigation Climatic Areas for Montana, 1986. Then, using Tables 1, 2, 3, 4, or 5, estimate potential yield for the specific crop.

Method 2. **AVERAGE YIELD METHOD**

Use the producers yield records (i.e., weight slips from the elevator, documented records, etc.) to average the yields obtained over a period of years. Yield estimates will be more accurate with a greater number of years of data. Years of exceptionally poor or exceptionally good yields should be eliminated from the calculation. Then you simply add up all the yields and divide by the number of years crops were produced.

Example:
1996 = 35 bu/ac
1997 = 38 bu/ac
1998 = 21 bu/ac (drought)
1999 = 40 bu/ac
2000 = 30 bu/ac
2001 = 33 bu/ac

$$\frac{35 + 38 + 40 + 30 + 33}{5 \text{ yrs}} = 35.2 \text{ bu/ac}$$

35.2 plus 5% = **37 BU/AC EXPECTED YIELD**

The expected yield can then be calculated by adding 5 percent onto the average yield. Five percent is added to figure in a little higher yield to cover those years when conditions are favorable and to take into account improved varieties and management techniques.

Soil Tests.

Current soil tests must be used to effectively plan for nutrient application. Current soil tests are those that are no older than five years. When a first time nutrient management plan is designed, especially if animal wastes are to be utilized as a source of nutrients, soil tests should be taken the year the plan is developed for most accurate planning. Due to potential annual variability, Nitrogen should be tested each year a crop is grown. Phosphorus and potassium may be completed once every three years until a baseline or consistent database is established. Application of micro-nutrients should be based on soil tests or plant analysis.

Regular testing of soil nutrient availability is essential for proper nutrient management decision making. Soil tests should be completed as close as possible to the time of seeding. When organic matter mineralizes it releases Nitrogen into the soil for potential plant uptake. The Montana Nitrogen fertilizer guidelines assume an average organic matter level of two percent. This is directly incorporated into the available Nitrogen requirements. For soils that have organic matter levels that exceed two percent, additional Nitrogen will be released to the soil through mineralization at a rate of 15-20 pounds of Nitrogen per acre for each one percent of organic matter. Therefore, for nutrient budgeting purposes, Nitrogen fertilizer rates can be decreased by 15-20 pounds Nitrogen per acre, if the soil has three percent organic matter or more, assuming moisture and heat conditions are adequate (limits: dry land crops maximum 30 pounds; irrigated crops maximum of 60 pounds).

Where annual precipitation is less than 14 inches, zero pounds of nitrate Nitrogen credit for mineralization should be assigned.

$$\frac{\text{Soil sample depth (in.)}}{6 \text{ (in.)}} \times 2 \times \_\_\_ \text{ ppm} = \text{lbs./acre } NO_3$$

Where two soil samples are taken and analyzed at different depths, i.e., at 0"- 12" and at 12"- 24", calculate pounds of nitrogen using the above formula for each sample depth and add the results.

For example: Soil was sampled at two different depths to get a better representation of nutrient concentrations. Results were:

Sample 1: 0-12" 32 ppm NO_3
Sample 2: 12-18" 8 ppm NO_3

Calculations – sample 1. $\frac{12"}{6"} \times 2 \times 32$ ppm = 128 lbs./ac NO_3

128 + 16 = 140 lbs./ac NO_3

- sample 2. $\frac{6"}{6"} \times 2 \times 8$ ppm = 16 lbs./ac NO_3

Nutrient Application Timing.

Apply nutrients as close to time of utilization as possible. This will ensure that potential for leaching, runoff, or volatilization will be minimized. Nitrogen application in the fall is not recommended except for fall seeded crops, with the exception of "starter fertilizer".

Field Risk Assessment.

When animal manure or other organic by-products are applied, a site-specific assessment of the potential for Phosphorus and Nitrogen transport from the field must be completed using the Montana Phosphorus Index and the Nitrogen Index. Copies of each completed index will be attached to this specification.

When the Phosphorus Index (PI) assessment rating is **N/A**, **LOW**, or **MEDIUM**, Nitrogen-based Phosphorus application plans will be developed such that manure application rates of Nitrogen do not exceed crop and soil needs based on the nutrient budget (see Table 8).

When the Phosphorus Index (PI) assessment rating is **HIGH**, Phosphorus-based plans will be developed such that manure application rates of Phosphorus do not exceed crop removal rates (see Table 9). When the Phosphorus Index (PI) assessment rating is **VERY HIGH**, Phosphorus-based plans will be developed such that manure application rates of Phosphorus do not exceed crop removal rates or no application of manure will be recommended (see Table 9).

GENERAL NUTRIENT MANAGEMENT CONSIDERATIONS

- Test soil, plants, water and organic material for nutrient content.
- Set realistic yield goals.
- Apply nutrients according to soil test analysis recommendations.
- Account for nutrient credits from all sources.
- Consider effects of drought or excess moisture on quantities of available nutrients.
- Use a water budget to guide timing of nutrient applications.
- Use cover and green manure crops where possible to recover or retain residual Nitrogen and other nutrients between cropping periods.
- Use split applications of Nitrogen fertilizer for greater nutrient efficiency.

- Returning crop residue to the soil requires additional Nitrogen due to microbial activity "tying up" some Nitrogen especially when adding high-carbon organic residues. As a rule, approximately ten pounds of Nitrogen for every 1,000 pounds of residue over 3,000 pounds should be added to the soil to offset this tie-up if Nitrogen is in deficit in the nutrient budget.

- If an irrigation water test has been completed, use Table 7 Nitrogen Contribution from Irrigation Water, to determine total pounds of Nitrogen supplied from water.

- Use Table 6, Nitrogen Fixation Estimates for Dryland Conditions, to estimate legume credit of nitrate-Nitrogen when a soil test is not available.

NUTRIENT MANAGEMENT ASSESSMENT. Make a site-specific environmental assessment of the potential risk of nutrient management. The boundary of the nutrient management assessment is the Agricultural Management Zone (AMZ), which is defined as the edge of field, bottom of the root zone, and top of crop canopy.

Within an area designated as having impaired or protected natural resources (soil, water, air, plants, and animals), the nutrient management plan should include an assessment of the potential risk for Nitrogen and Phosphorus to contribute to water quality impairment.

The Leaching Index (LI), Nitrogen Index, Phosphorus Index (PI), erosion prediction models, and water quality monitoring, may all be used to assess risk.

Evaluate other areas that might have high levels of nutrients, produced or applied, that may contribute to environmental degradation. For example, areas with high livestock concentrations for large areas of high intensity cropping, such as continuous potatoes, corn, or specialty crops, may be contributing heavy nutrient loads to surface or ground water.

Conservation practices and management techniques will be implemented with nutrient management to mitigate any unacceptable risks.

GUIDELINES FOR OPERATION AND MAINTENANCE

- Review the nutrient management component of the conservation plan annually and make adjustments when needed.

- Calibrate application equipment to ensure uniform distribution and accurate application rates.

- Protect nutrient storage areas from weather to minimize runoff and leakage.

- Avoid unnecessary exposure to fertilizer and organic waste, and wear protective clothing when necessary.

- Observe setbacks required for nutrient applications adjacent to water bodies, drainageways, and other sensitive areas.

- Maintain records of nutrient application as required by state, tribal, and local regulations.

- Clean up residual material from equipment and dispose of properly.

TABLE 1. ESTIMATED SPRING WHEAT YIELDS[a] BASED ON STORED SOIL WATER AND GROWING SEASON PRECIPITATION[a]

CONSUMPTIVE USE AREA	STORED SOIL WATER + GROWING SEASON PRECIPITATION (IN.) 4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	BUSHELS PER ACRE[bc]														
1. High	0	6	10	15	20	24	29	34	39	43	48	53	57	62	67
2. Moderately High	0	6	11	16	21	27	32	37	42	47	52	57	62	67	72
3. Moderate	0	7	13	19	24	30	36	42	48	53	59	65	71	77	82
4. Moderately Low	0	7	13	20	26	32	38	44	50	56	62	68	74	80	87

TABLE 2. ESTIMATED BARLEY YIELDS[a] BASED ON STORED SOIL WATER AND GROWING SEASON PRECIPITATION[a]

CONSUMPTIVE USE AREA	STORED SOIL WATER + GROWING SEASON PRECIPITATION (IN.) 4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	BUSHELS PER ACRE[bc]														
1. High	6	13	20	27	34	41	48	55	62	69	76	83	90	97	104
2. Moderately High	7	14	22	30	37	45	52	60	68	75	83	90	98	106	113
3. Moderate	8	16	25	33	42	50	59	67	76	84	93	101	110	118	127
4. Moderately Low	8	17	26	35	44	53	62	71	80	89	98	107	116	125	134

[a] Estimated yields reflect consumptive use data from Huntley, Havre, Sidney, Conrad, Kalispell, Bozeman, and Moccasin.

[b] Yields may vary from estimates due to climatic conditions, weeds, disease, insects, lodging, or stand density.

[c] When rooting depths are limited by rocks, gravel, or impermeable layers such as shale, yields may vary.

TABLE 3. ESTIMATED WINTER WHEAT YIELDS[a] BASED ON STORED SOIL WATER AND GROWING SEASON PRECIPITATION[a]

CONSUMPTIVE USE AREA	STORED SOIL WATER + GROWING SEASON PRECIPITATION (IN.) 4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	BUSHELS PER ACRE[bc]														
1. High	0	6	11	17	22	28	33	38	44	49	55	60	65	71	76
2. Moderately High	0	6	12	18	24	30	35	41	47	53	59	64	70	76	82
3. Moderate	0	7	14	20	27	34	40	47	53	60	67	73	80	86	93
4. Moderately Low	0	8	15	22	29	36	43	50	57	64	71	78	85	92	99

TABLE 4. ESTIMATED OAT YIELDS[a] BASED ON STORED SOIL WATER AND GROWING SEASON PRECIPITATION[a]

CONSUMPTIVE USE AREA	STORED SOIL WATER + GROWING SEASON PRECIPITATION (IN.) 4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	BUSHELS PER ACRE[bc]														
1. High	0	2	11	21	30	39	49	58	68	77	86	96	105	115	124
2. Moderately High	0	2	12	23	33	43	54	64	74	84	95	105	115	126	136
3. Moderate	0	2	14	26	37	49	61	72	84	96	108	119	131	143	154
4. Moderately Low	0	2	15	28	40	52	65	78	90	102	115	128	140	152	165

TABLE 5. ESTIMATED SAFFLOWER YIELDS[a] BASED ON STORED SOIL WATER AND GROWING SEASON PRECIPITATION[a]

CONSUMPTIVE USE AREA	STORED SOIL WATER + GROWING SEASON PRECIPITATION (IN.)														
	8	9	10	11	12	13	14	15	16	17	18	19	20	21	228
	POUNDS PER ACRE[bc]														
2. Moderately High	115	279	443	607	771	935	1,099	1,263	1,427	1,591	1,755	1,919	2,083	2,247	2,411

a Estimated yields reflect consumptive use data from Huntley, Havre, Sidney, Conrad, Kalispell, Bozeman, and Moccasin.

b Yields may vary from estimates due to climatic conditions, weeds, disease, insects, lodging, or stand density.

c When rooting depths are limited by rocks, gravel, or impermeable layers such as shale, yields may vary.

TABLE 6. NITROGEN FIXATION ESTIMATES FOR DRYLAND CONDITIONS[1]

Legume	N FIXATION (Lb./acre)
Alfalfa (after harvest)	40-80
Alfalfa (green manure)	80-90
Spring Pea	40-90
Winter Pea	70-100
Lentil	30-100
Chickpea	30-90
Fababean	50-125
Lupin	50-55
Hairy Vetch	90-100
Sweetclover (annual)	15-20
Sweetclover (biennial)	80-150
Red Clover	50-125
Black Medic	15-25

1 The large variation in estimates is attributed to different years, climate, management, etc.

TABLE 7. NITROGEN CONTRIBUTION FROM IRRIGATION WATER

N IN WATER (PPM)	Water Application Rate (Acre-feet) (LBS N/ACRE) 0.5	1.0	1.5
2	3	5	8
4	5	11	16
6	8	16	24
8	11	22	32
10	13	27	40

TABLE 8. PHOSPHORUS APPLICATION BASED ON PI

PHOSPHORUS RISK RATING	PHOSPHORUS APPLICATION
Low Risk	Nitrogen Based
Medium Risk	Nitrogen Based
High Risk	Phosphorus Based (up to crop removal amounts)
Very High Risk	Phosphorus based or no application

TABLE 9. PHOSPHORUS APPLICATION FROM SOIL TEST RESULTS

SOIL TEST PHOSPHORUS LEVEL	PHOSPHORUS APPLICATION
≤8.0	Nitrogen Based
8.1 – 25.0	Nitrogen Based
25.1 – 100.0	Phosphorus Based
100.1 – 150.0	Phosphorus Based (up to crop removal)
>150.0*	No Application

* Estimate; subject to modification based on the development of new research relevant to Montana

TABLE 10. GYPSUM REQUIREMENTS FOR SODIUM AFFECTED SOILS

SAR*	GYPSUM ($CaSO_4 \cdot 2H_2O$) lbs/10,000 ft^2
0 –12	0
12 – 21	50
21 – 31	100
31 – 40	150

*SAR = Sodium adsorption ratio, 0 – 6 inch sample depth

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NATURAL RESOURCES CONSERVATION SERVICE
MONTANA CONSERVATION PRACTICE JOB SHEET

NUTRIENT MANAGEMENT (ACRE)

NUTRIENT BUDGET

CODE 590B

LANDOWNER/OPERATOR _____ FIELD(S) _____

PLANNER _____ JOB CLASS _____ DATE _____

PURPOSE (CHECK ALL THAT APPLY):

☐	Budget and supply nutrients/amendments for plant production source.	☐	Utilize manure/organic materials as a nutrient source.
☐	Protect surface and groundwater quality.	☐	Maintain or improve soil conditions.

PRODUCTION, FIELD CONDITIONS AND RECOMMENDATIONS

CROP ROTATION AND YIELD					
CROP/FORAGE	YIELD	CROP/FORAGE	YIELD	CROP/FORAGE	YIELD

CURRENT SOIL TEST LEVELS SOIL ANALYSIS DATE_____								
NO_3	UNITS	P	UNITS	K	UNITS	pH	O.M.%	E.C.

RECOMMENDED NUTRIENTS TO MEET YIELDS			
NO_3	P_2O_5	K_2O	pH

NUTRIENT SOURCES

CREDITS		NO_3 POUNDS PER ACRE		P_2O_5 POUNDS PER ACRE		K_2O POUNDS PER ACRE	
1. Nitrogen credits from previous crop or legume.				0		0	
2. Residual **Nitrate** from long-term manure application.				0		0	
3. **Nitrate** from irrigation water.				0		0	
4. Other **Nitrate** (from rainwater, O.M., etc.)				0		0	
5. TOTAL CREDITS				0		0	
NUTRIENTS APPLIED TO FIELD		BUDGET	ADJUST	BUDGET	ADJUST	BUDGET	ADJUST
6. Credits (from Row 5, above)							
7. Fertilizer	Starter						
	Commercial						
8. Manure/Organic Materials							
9. **SUBTOTAL (SUM OF LINES 6, 7, and 8)**							
10. **NUTRIENTS RECOMMENDED FOR YIELD**							
11. Nutrient Status (subtract line 10 from line 9)							
12. Additional N needed to offset tie-up (MT590)				ENTER TOTAL LBS. RESIDUE			
TOTAL CROP NUTRIENT APPLICATION							

CERTIFICATION STATEMENT:

I hereby certify that this practice has been installed in accordance with NRCS standards and specifications.

NRCS Conservationist _____ JOB APPROVAL AUTHORITY _____ Date _____

_____ Date _____

MT590B-JS2

INSTRUCTIONS:

When filling out the nutrient budget, realistic yields may have to be adjusted to reflect the amount of nutrients available considering nutrients may not be available for application prior to planting the planned crop. For example, if a soil test is completed in October and a spring-seeded crop is planned, it is already too late to plant green manure or cover crops to add nutrients. Therefore, the budget will be completed to simply ascertain the potential yield to expect assuming moisture is not limiting.

Crop rotation and yield: Enter the planned crop and realistic yield goals.

Current soil test levels: Enter the soil test levels from the analysis and appropriate units. Enter date of soil analysis.

Recommended nutrients to meet yield: Enter the Montana State University (MSU) nutrient recommendations to reach the realistic yield goals.

Nutrient Credits

1. Enter the nitrate-nitrogen credits from the soil analysis OR estimated nitrates from previous season green manure of cover crop (see specification for estimates).

2. Enter residual nitrates available from manure applications (only required when current soil test is unavailable).

3. Enter nitrates available from application of irrigation water (from a water analysis).

4. Enter amount of nitrate nitrogen available from mineralization (see specification for details).

5. Add lines 1-4 for estimated currently available total nitrate nitrogen.

Applied nutrients

6. In the budget column, enter the nutrients estimated from line 5.

7. If organic forms of commercial fertilizer are used, enter the actual amounts of N, P, and K applied.

8. If manure was applied, enter the actual amounts of N, P, and K available to the plant based on amounts applied (from manure analysis and amount applied).

9. In the budget column, enter the subtotal of estimated nutrients available to raise a crop or forage.

10. Enter the amounts of recommended nutrients from the "Recommended Nutrients" section.

11. Subtract. This number reflects the amount of nutrients available to grow the crop/forage. From this number, a better estimate of appropriate yield can be calculated. For example, if spring wheat yields are estimated at 35 bushels per acre but only 60 lbs of nitrogen are present in the soil, the producer can only expect an 18-20 bushel per acre yield.

12. If high carbon crops are grown in the previous year, nitrogen may be tied up temporarily while carbon is broken down into available forms of nitrogen. In general, 10 pounds of additional nitrogen is needed per 1,000 pounds of residue over 3,500 pounds (example 5,000 pounds of residue from crop – 3,500 = 1,500 Lbs. Add 15 pounds of N.

13. In the "adjustment column", enter the amounts of nutrients for each block adding estimated amounts of actual N from organic commercial fertilizer, from manure applications, from green manure, or from cover crops. The goal is to have enough nutrients (plus a little extra) available to the plant to yield the objective yield. If the results calculated in Line 11 total "0", the nutrient available balance the yields expected. If they do not balance, addition of nutrients to the soil will be required.

NRCS, MT
May 2010

N. J0B-JS3

NATURAL RESOURCES CONSERVATION SERVICE
MONTANA CONSERVATION PRACTICE JOB SHEET

NUTRIENT MANAGEMENT (ACRE)

FIELD SPECIFIC NUTRIENT APPLICATION PLAN

CODE 590B

PRODUCER _____ TRACT NO._____ FIELD NO._____ DATE_____

PLANNER _____ APPROVAL _____

JOB APPROVAL AUTHORITY

MANURE

YEAR	FIELD(S)	CROP	SPREADABLE ACRES [1]	RECOMMENDED TIMING		RECOMMENDED RATE 1,000 gal / ac / yr. Tons / Ac / Yr.	NUTRIENTS APPLIED AT SELECTED RATE Lbs. / Ac / Yr.		
				SEASON FALL, SPRING, FALL AND SPRING, OTHER	INCORPORATION <12 hrs, <4 days, >4 days		NO_3	P_2O_5	K_2O

FERTILIZER

YEAR	FIELD(S)	CROP	ACRES	RECOMMENDED TIMING AND AMOUNT OF NUTRIENTS (LB./AC.) [2]						NUTRIENTS APPLIED AT SELECTED RATE Lbs. / Ac / Yr.		
				PRE-PLANT (spring, fall)	AMOUNT	PLANTING: STARTER	AMOUNT	SIDEDRESS	AMOUNT	NO_3	P_2O_5	K_2O

[1] Spreadable acres are less than total acres if waterways and other concentrated flow areas exist (no manure application zone).

[2] From Nutrient Budget Job Sheet, MT590B, May 2010.

CERTIFICATION STATEMENT:

I hereby certify that this practice has been installed in accordance with NRCS standards and specifications.

_____ _____ _____

NRCS Conservationist JOB APPROVAL AUTHORITY Date

_____ _____

Date

NRCS, MT
May 2010

NATURAL RESOURCES CONSERVATION SERVICE
MONTANA CONSERVATION PRACTICE JOB SHEET

NUTRIENT MANAGEMENT (ACRE)

FIELD SPECIFIC NUTRIENT APPLICATION PLAN

CODE 590B

PRODUCER _____ TRACT NO. _____ FIELD NO. _____ DATE _____

PLANNER _____ APPROVAL _____

JOB APPROVAL AUTHORITY

FERTILIZER

YEAR	FIELD(S)	CROP	ACRES	RECOMMENDED TIMING AND AMOUNT OF NUTRIENTS (LB./AC.) [2]						NUTRIENTS APPLIED AT SELECTED RATE Lbs. / Ac / Yr.		
				PRE-PLANT (spring, fall)	AMOUNT	PLANTING: STARTER	AMOUNT	SIDEDRESS	AMOUNT	NO_3	P_2O_5	K_2O